Human Spaceflight, Microgravity and Exploration NEWS

SEPTEMBER 2007

Compiled by
HME Science and Applications Division

THE S&A DIVISION OF THE DIRECTORATE OF HUMAN SPACEFLIGHT, MICROGRAVITY AND EXPLORATION RELEASES A NEWSLETTER ON HIGHLIGHTS OF THE MONTH. CLICKING ON ONE OF THE HEADLINES BELOW WILL TAKE YOU TO THE RELEVANT TOPIC.

FEATURES

PUBLICATIONS ANNOUNCED IN SEPTEMBER 2007

WHITE, OLIVER, PENTA, M., AND THONNARD, J.-L.:
A NEW DEVICE TO MEASURE THE THREE DIMENSIONAL FORCES AND TORQUES IN PRECISION GRIP
Journal of Medical Engineering & Technology, in Press.

CAIANI, E. G., L. WEINERT, M. TAKEUCHI, F. VERONESI, L. SUGENG, C. CORSI, A. CAPDEROU, S. CERUTTI, P. VAIDA, AND R.M. LANG:
EVALUATION OF ALTERATIONS ON MITRALANNULUS VELOCITIES, STRAIN, AND STRAIN RATE DUE TO ABRUPT CHANGES IN PRELOAD ELICITED BY PARABOLIC FLIGHT
J. Appl Physiol 103: 80-87, 2007.

LAKEHAL, DJAMEL, G. LARRIGNON, C. NARAYANAN:
COMPUTATIONAL HEAT TRANSFER AND TWO-PHASE FLOW TOPOLOGY IN MINIATURE TUBES
Microfluid Nanofluid, Springer. Acceptecd for publication 16 April 2007.

Das, K.S., and C.A. Ward:
SURFACE THERMAL CAPACITY AND ITS EFFECTS ON THE BOUNDARY CONDITIONS AT FLUID-FLUID INTERFACES
Physical Review E 75, 065303(R) (2007)

ROISMAN, ILIA, T. GAMBARYAN-ROISMAN, O. KYRIOPOULOS, , P. STEPHAN, C. TROPEA:
BREAKUP AND ATOMIZATION OF A STRETCHING CROWN
Physical Review E 76, 026302 (2007). Scientific paper.

BRINCKMANN, ENNO:
BIOLOGY IN SPACE AND LIFE ON EARTH
ISBN-10: 3-527-40668-9, ISBN-13: 978-3-527-40668-5. Wiley-VCH, Berlin, August 2007. Textbook.

VERHEYDEN, B., F. BECKERS, K. COUCKUYT, J. LIU AND A.E. AUBERT:
RESPIRATORY MODULATION OF CARDIOVASCULAR RHYTHMS BEFORE AND AFTER SHORT-DURATION HUMAN SPACEFLIGHT
Acta Physiol 2007, in press. Scientific paper.

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ARABIDOPSIS THALIANA - THE GUINEA PIG OF THE PLANTS IN THE EUROPEAN MODULAR CULTIVATION SYSTEM ON ISS

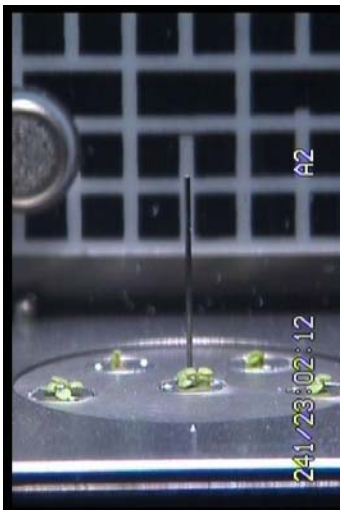
THE VALUE OF INVESTIGATING THE SAME ORGANISM AGAIN AND AGAIN – FOR DIFFERENT QUALITIES – IS IN LIFE SCIENCES A KNOWN ROUTINE: OPTIMALLY ONLY ONE VARIABLE SHOULD BE INVESTIGATED AT A TIME, ALL OTHERS REMAINING CONSTANT, BUT THAT SITUATION IS THE EXCEPTION RATHER THAN THE RULE.
NEVERTHELESS, *ARABIDOPSIS THALIANA* IS AN ATTRACTIVE PLANT IN THAT RESPECT AS THE AMOUNT OF KNOWLEDGE ABOUT THAT ORGANISM IS RATHER SUBSTANTIAL. THE EXPERIMENT MULTIGEN IS MAKING USE OF THESE QUALITIES.

Having played a central role in plant research since the 1870's - its chromosome number was determined in 1907 - *A.thaliana* was proposed to be THE model organism in 1943, and gradually since then took centre stage in the search for new knowledge of 'how plants work'. The organism is so well investigated, that it forms the basis for the understanding of the functioning of plants with flowers. The entire genome of *A. thaliana* has also been totally sequenced recently.

MULTIGEN-1 growth chambers Final Acceptance Review in Bergen (N). From right: Caroline Bøe (Prototech), Geir Omdal (Prototech), A.Salado (NTE), T.Heller (Astrium FN, kneeling), L.Briganti (ESA), C.Brillouet (ESA), Bjørnar Vasenden (Prototech), P.Trivedi (ESA), A.Schwarzwaelder (Astrium FN)

In relation to space flight, genetic research and aspects of dependency of growth of direction of gravity, response to diverse wavelengths of light and circadian rhythm, have been central. Onboard the ISS, one factor is absent, namely gravity, allowing to study how the plant develops and grows without it. That is the main focus of the MULTIGEN experiment.

Arabidopsis does have other compelling qualities as well: It is a low growth plant with a short 70 days seed-to-seed cycle, which allows for a few generations of the plant to develop, mature, reproduce and wither without the influence of gravity, in order to see what interventions in the earlier generation have lead to, in terms of mutations, sensitivity and other developmental appearances. MULTIGEN-1 will be a "seed-to-seed" experiment, allowing for a full development cycle (one generation) of *A. thaliana* in space.



MULITGEN-1 on ISS, germination of Arabidopsis thaliana seeds, 5 days old

MULTIGEN-1 ground testing on EMCS ERM, a fully grown plant

Eventually the target of the MULTIGEN experiments is to observe the so-called 'gene expression', e.g. the way the genetic material reacts and adapts to - among others - environmental factors, by 'switching genes on or off' in response to changes. This in turn has an effect on the signalling level of the cell, the response on molecular level leading to an 'appropriate' response to the stimulus. By use of a DNA chip, where the status of thousands of genes is 'frozen' by immobilisation at a certain, selected point in time, one can analyse the response to a certain stimulus. In this manner one should be able to register how many and which genes change status - compared to a control - in response to absence of gravity. This will be the goal of the follow-on MULTIGEN-2 experiment.

The MULTIGEN-1 experiment (Iversen et al.) selected by ESA, has just been started late August 2007 using the European Modular Cultivation System (EMCS), presently located in the ISS science module Destiny.

On the technical equipment level there are challenges: As gravity is absent onboard ISS, provision of water and nutrients has to be particularly cared for. Thus, an artificial growth medium, especially adapted to the scale of the experiment (smalll) and binding and release of nutrients has been in focus. Tests have defined the best solution here. In order to rule out dissimilarities apart from the g-load, a 1-g control set of plant will be onboard, living in a centrifuge providing Earth gravity level. As well a control set will be grown on Earth during the same time, under as identical conditions as possible.

EMCS on ISS (in EXPRESS rack)

Finally, the environmental control system in the EMCS experiment containers (EC) needs to keep critical parameters within acceptable values; even though it was decided by the investigator to use cabin air in the growth chamber, as the potentially relatively elevated CO2 concentration on the ISS of up to 1% could be faced, plants develop the gas ethylene as a waste product, which gas needs to be removed by means of special filters absorbing it. Concentrations of ethylene as low as 1 ppm (parts per million) are considered harmful to plant growth. This in turn has created the potential problem that the forced ventilation around the plants could dry them out. Finally, the light on the plants needs to be of a known and well defined wavelength, as plants react differently to different colours of light. All in all a somewhat more complex 'growth house' than normally found in the landscape around us.

Arbidopsis thaliana is the subject for the experiments GENARA, WAICO, and TROPI as well. Each of these has a scientific focus different fro MULTIGEN's, however.

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UPCOMING SCIENCE FLIGHTS – A BUSY AUTUMN 2007 FOR ESA-HME

THIS AUTUMN A LARGE NUMBER OF SPACEFLIGHTS AND PARABOLIC ATMOSPHERIC FLIGHTS WILL BE REALISED WITH ESA EXPERIMENTS ONBOARD. EACH OF THESE WILL CARRY A WELL –PREPARED PAYLOAD OF EXPERIMENTS THAT HAVE BEEN UNDER WAY FOR SHORTER OR LONGER TIME. COMMON FOR ALL, HOWEVER, IS THAT THEY ORIGINATE FROM THE SELECTED FLIGHT EXPERIMENT POOL, WHICH IS WHERE EXPERIMENTS ARE 'PARKED' AFTER INITIAL EVALUATION AND SELECTION.

Despite the long wait for ESA's Columbus module to become a part of the International Space station, a number of different flight opportunities help work off experiments from the experiment pool, and this autumn is the busiest half year since long:

September 14, 2007 is the day where the Russian FOTON capsule, with **the FOTON-M3 mission,** unmanned, but environmentally controlled spacecraft for biological and physical sciences will lift-off from Baikhonour, Kazakstan
FOTON-M3 is the next in the row after ESA's involvement in the FOTON-M2 that flew in June 2006. Read details of the flight on the following pages.

October 10, 2007, the **15S Soyuz mission** will be launched from Baikhonour, Kazakstan. These missions are of the Soyuz capsule exchange type, which typically have a duration in the order of 10 days. ESA has since the 12S mission in 2006 routinely had a set of experiments onboard these exchange missions, in which context the KUBIK facility is in the process of becoming a regular 'work horse' for biological experiments. It is a handy and versatile facility with a rather short turn-around time. Three biology experiments will be onboard and a handful of experiments mainly related to physiology will be performed in relation to that mission as well.

October 16, 2007, the next NASA **Shuttle flight STS-120**, by ESA called the ESPERIA mission, is flying ESA astronaut Paulo Nespoli to the ISS together with 'Node 2' – a connection module needed in order to receive and connect the later launched ESA ISS module Columbus with the NASA Destiny module and Japanese Experiment Module. The latter is to be launched next spring. In addition Node 2 has several crucial functions for future smooth ISS operations.

November 17 and 25, Sounding Rocket flights TEXUS 44 & 45 will be launched from ESRANGE in Kiruna, Sweden. System integration will take place between 15 and 29 October in Ottobrun, Germany. The entire payload will then be transported to Kiruna, Sweden on truck, in time for a 5 November launch campaign start. Texus 44 will have some physical sciences and one biology experiment onboard. Texus 45 will carry only one module.

November 13-15, **Parabolic Flight campaign 46** is scheduled to take place. Onboard will be a number of technology testing activities, eight Physical Sciences and three Life Sciences experiments.

December 18-20, **Parabolic Flight campaign 47** will be flown. The preliminary payload lifts around 8 physical sciences, 3 life sciences and a few technology testing experiments.

December 6, 2007 is the very long awaited launch day for **ESA's ISS module Columbus.** It will carry a number of experiment racks already mounted and ready to be activated, once Columbus has been properly connected to the ISS infrastructure, checked out and confirmed for full operation.

Interesting links:

Find information on **Node 2** here.
See the details of the STS-120 specific **experiment programme** here
Check the overall **mission objective of the STS-120** mission here.

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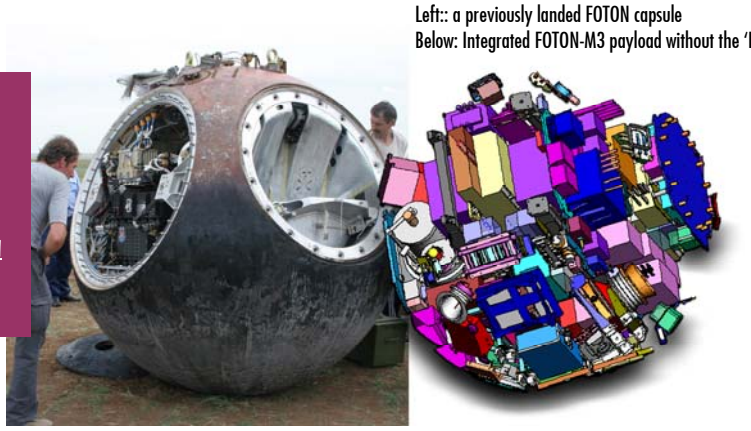
FOTON-M3 - A 2-WEEK MISSION PACKED WITH SCIENCE

INTEGRATION OF THE FOTON CAPSULE IS LIKE A 3-DIMENSIONAL PUZZLE – EQUIPMENT, CABLES AND DEVICES HAVE TO GO IN AN ACCURATE SEQUENCE, NOT THE LEAST BECAUSE OF THE SEVERE RESTRICTION ON ACCESS; EVERYTHING HAS TO BE ENTERED VIA THE CIRCULAR HATCH OPENING. AND THE ENTIRE PAYLOAD, WHEN IN PLACE, HAS TO BE IN BALANCE SUCH THAT THE CAPSULE HAS THE CENTRE OF GRAVITY WHERE IT IS SUPPOSED TO. NO TRIVIAL TASK AT ALL.

FOTON ANIMATIONS (Flash):

- Fairing separation
- Orbital injection
- Spacecraft fully automated
- YES2

Left:: a previously landed FOTON capsule
Below: Integrated FOTON-M3 payload without the 'FOTON-shell'



The more than 40 experiments are now since some time placed in FOTON and ready to go on 14 September 2007 from the launch site in Baikhonour, Kazakstan. Still to be loaded, though, are some 'late access' items that typically go onboard within the last 24-48 hours before launch, e.g. biological samples, which require a well controlled environment. The latest sample preparation took place over the weekend, in order to leave ESTEC not later than 2 am on September 10.

The FOTON-M3 payload consists of an impressive number of individual and very different experiments, listed below. For each experiment a link to the best available information is provided under the 'short name' – the name under which the experiment is known on this mission.

The many experiments are distributed on the following experiment envelopes:

Fluid Physics, 2 experiments:	GradFlex
Crude oil diffusion effects, 3 experiments:	SCCO
Cellular Biology, 5 experiments:	Biobox[1]
Bone cells growth , 6 experiments:	Eristo/Osteo
Biology of water organisms, 2 experiments:	AquaHab
Material sciences, 7 co-operative experiments:	Polizon
Protein crystals growth, 2 experiments:	Granada
Bone cell sensitivity to stimulation:	Freqbone
Exobiology and space exposure, 10 experiments	Biopan[2,3]
Meteorite re-entry, 2 experiments	Stone[4]
Onboard payload assist:	TeleSupport
Technology demonstrator:	Dimac
Technology demonstrator:	Battery
Technology demonstrator:	Teplo
Technology demonstrator:	OWLS
Students' project:	SEEK
Students' project:	YES-2

For access to the full FOTON Users Guide, please click here , or Download the FOTON-M3 brochure here.

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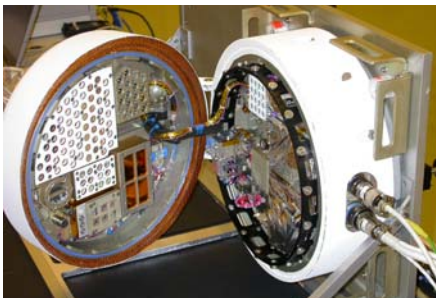
[1] When document opens, scroll down to p. 22, section 6.5.1.1
[2] For a detailed account, see special article in this newsletter on the Biopan experiments
[3] When document opens, scroll down to p. 23, section 6.5.1.2
[4] When document opens, scroll down to p. 26, section 6.5.1.3

BIOPAN'S ROBUST PASSENGERS – INTER-PLANETARY TRAVEL CANDIDATES? (FOTON-M3 SEPTEMBER 2007)



Biopan with all experiments integrated

ROTIFERS, LICHENS, TARDIGRADES AND ***NEMATODES*** …. ORGANISMS THAT ARE NOT REALLY FAMILIAR TO MOST OF US, BUT WHO NEVERTHELESS WILL BE MAKING AN IMPORTANT JOURNEY ON OUR BEHALF IN SEPTEMBER THIS YEAR. IN THE SEARCH FOR CANDIDATE SPECIES THAT IN THE ANCIENT PAST COULD HAVE TRAVELLED THE UNIVERSE EXPOSED TO EXTREME TEMPERATURE AND RADIATION CONDITIONS, AND STILL AFTER THAT BEING ABLE TO SUSTAIN LIFE AND REPRODUCE UPON ARRIVAL ON ANOTHER CELESTIAL BODY, THESE ORGANISMS ARE ONBOARD BIOPAN.

Other candidates for interplanetary transfer of life are flown, such as yeast, endolithic and dehydrated bacteria, bacterial spores, organic molecules and freeze-dried antibodies.

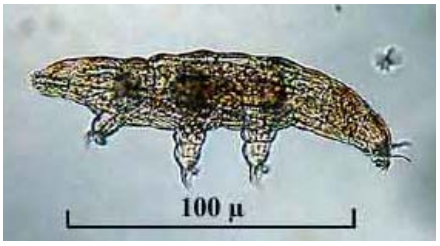
Attached to the outer surface of the FOTON-M3 spacecraft, BIOPAN accommodates a large number of species in separate specialised enclosures. Once in orbit the protective lid on BIOPAN will be opened allowing space vacuum, extreme temperatures and cosmic and unfiltered solar radiation access to the samples. In particular the effect of solar UV-C radiation, normally fatal to all living organisms if exposed unprotected for a period of time, is being investigated in the samples of a multitude of robust species.

So how were these 'passengers' selected? Which qualities do they have that others do not? Common for them all is the ability to recover from **anhydrobiosis**, or the 'life without water'. They each possess their own very specific kind of robustness in that context:

- The **nematodes** (small worms) onboard, *Panagrolaimus rigidus*, have shown that they can survive a long period of anhydrobiosis, to subsequently grow and reproduce when hydrated again. Other nematodes found in Antarctica have the ability to completely freeze up internally without impairment of the vital functions when thawed again. Mechanisms for how they survive are investigated.

- Four **tardigrade** species (Latin: slow walker, 0.3 mm size) are onboard. The small animals are also called 'water bears' from their resemblance with a bear when they move, and can be found wherever water is present. The *M. tardigradum* is the most widely found, and is particularly robust.

  Dried up it remains inactive for long periods of time, until water again comes its way. Watch a walking 'water bear', click on 'the video' here).



Milnesium tardigradum

- The **rotifer** (from latin: wheel bearer, 0.1-0.3 mm size) a freshwater organism with a fixed number of around 1000 cells in total, becomes inactive and stays that way when exposed to dissication or almost complete removal of body water, until being re-hydrated. It then becomes reactivated within a few hours to regain full body functions. It can 'hibernate' in that form for many years without eventual loss of vital functions. It has name after the wheel-like movement of the cilia (hair-cell outgrowths) when it feeds and moves.

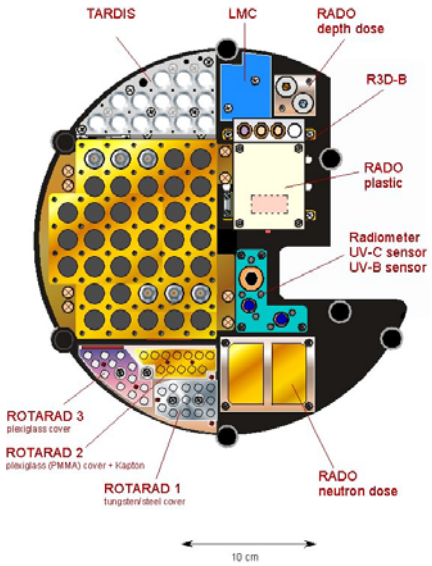
Rotifer *Macrotrachela quadricornifera*

- The extreme species of the **lichens**, a colonial low growth, are usually found on Earth in very dry, elevated areas – over 1000 meters of altitude - with cold windy and overcast winters. Lichens withstand extreme dehydration and temperature conditions.

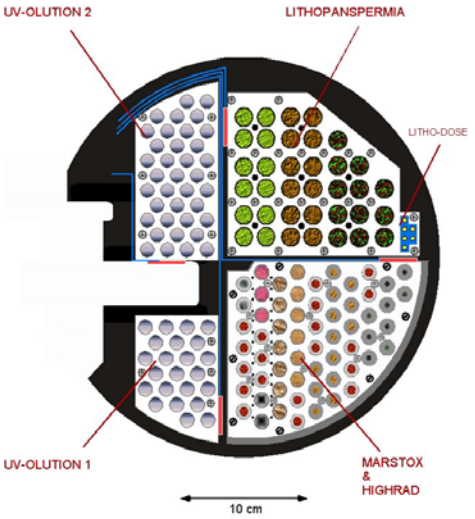
Rhizicarpon geographicum[5]

All these organisms are exposed to space vacuum with diverse sorts of protection covering the sample pits, in order to investigate these effects. BIOPAN registers the amount and timing of the abundant radiation that the samples receive via diverse types of integrated and independent dosimeters. Before return, after the BIOPAN lid has been open to Space for 10 days, it is closed mechanically to protect against re-entry into the Earths atmosphere.

BIOPAN opened – Species location



BIOPAN-6 BOTTOM PLATE
15 August 2006



BIOPAN-6 LID PLATE
20 July 2006

BIOPAN 'PASSENGERS':

- 4 TARDIGRADE SPECIES
- 3 LICHEN SPECIES
- 2 ENDOLITHIC BACTERIA
- 2 YEAST TYPES
- 1 NEMATODE SPECIES
- 1 ROTIFER SPECIES
- 1 DEHYDRATED BACTERIA
- 1 BACTERIAL SPORE
- 1 SET OF ORGANIC MOLECULES
- 1 SET OF FROZEN ANTIBODIES

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[5] http://www.lichen.com/biology.html

BIO PAYLOADS WITH KUBIK - BIO-3 ONBOARD THE 15S MISSION IN OCTOBER 2007

Dutch astronaut Andre Kuipers during training on how to work on the Kubik incubator

THE "BIO" EXPERIMENT PACKAGE BECAME A CONCEPT UNDER WHICH TO GET THE MORE SIMPLY DESIGNED, ALBEIT NOT NECESSCARILY UNSOPHISTICATED, BIOLOGICAL EXPERIMENTS PERFORMED AT THE FIRST FLIGHT OF THE KUBIK FACILITY ON BOARD THE DUTCH DELTA MISSION. THAT MISSION WAS FLOWN IN 2004 IN THE CONTEXT OF ONE OF THE SOYUZ EXCHANGE FLIGHTS.

TO FIND OPTIMAL USE OF THESE SHORT FLIGHTS HAS BEEN A FOCUS FOR SOME TIME, AND IT SEEMS AS IF THE USE OF THE KUBIK FACILITY HAS BECOME THE 'FACILITY OF CHOICE' FOR BIOLOGICAL EXPERIMENTS, WHICH DO NOT REQUIRE FREQUENT AND COMPLEX HANDLING.

Presently, finalisation of the preparation for the BIO-3 payload, including 3 separate experiments, is under way. The BIO-3 package will be onboard the 15S (Soyuz) mission, to be launched on 10 October this year.

The quality of the BIO payload system is, that it offers a fairly high degree of flexibility, based on the ambition of having roughly one such flight per year. Development time is generally in the order of 18 months from kick-off till flight of an experiment, which can be considered very short in space experimentation context.

The BIO-1 payload (12S) March 2006 was the first KUBIK mission after the DELTA mission. BIO-1 had 6 experiments onboard, which all gave almost 100% of expected output.

In the BIO-2 payload, which was performed in the context of the Astrolab mission during second half of 2006, one experiment used KUBIK. In total three experiments were flown on that mission, the LEUKIN-2, BASE-A and YING-A. In time for performing the LEUKIN experiment, which needed a certain containment level, the Portable Glovebox (PGB) had been brought on board *(see details on the PGB in Newsletter June 2007 here)*. The PGB filter characteristics were specifically suited for support of that type of experiment.

The Kubik incubators prepared for the launch of the Delta mission

After the initial experiences with the BIO-1 and -2 payloads, BIO-3 has been developed under a much more streamlined scheme, which has removed a considerable amount of variables and uncertainties. Thus, one can say that BIO-3 represents the state-of-the-art of development flow for ESA's biological experiment packages of the identified category.

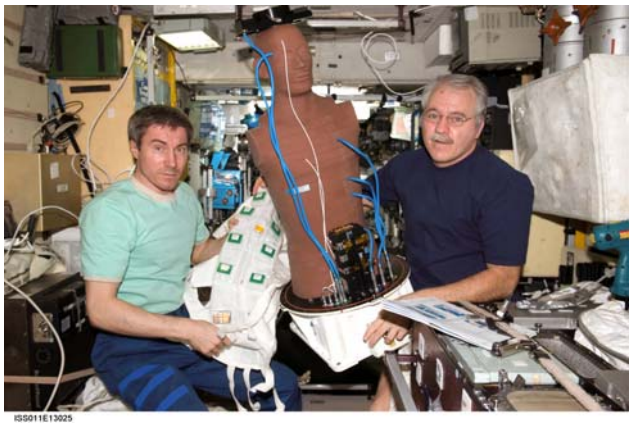
Kubik with centrifuge configuration loaded with experiment containers

At the end of June this year, the BIO-3 Experiment Sequence Test was held in Zurich. The EST is performed in the form of an end-to-end test that guarantees that nothing has been overseen. BIO-3 will launch on 10 October onboard the 15S mission.

Preparation of the BIO-4 payload is in full swing. A total of six experiments are foreseen. The BIO-5 payload is in the beginning of its planning and may have 5 experiments onboard, but it is too early to confirm any details of that mission.

SHORT UPDATES

MATROSHKA RE-ACTIVATION



Matroshka with (previous) ISS Expedition 11 Commander Sergei Krikalev (left) and ISS Expedition 11 Flight Engineer John Phillips (right)

On 4 September the Acceptance Test 2 (AT-2) has successfully taken place in Moscow, for the new passive detectors for the Matroshka facility to go to the ISS onboard the 15S mission on 10 October. Onboard the Progress 27P, presently slated for a 12 December launch, additional cabling and parts will be sent to the ISS for a full activation. This forms the basis for a new 5 months measurement period for the Matroshka-2B version.

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PUBLICATIONS ANNOUNCED IN THE PERIOD OF SEPTEMBER 2007

WHITE, OLIVER, PENTA, M., AND THONNARD, J.-L.:

A NEW DEVICE TO MEASURE THE THREE DIMENSIONAL FORCES AND TORQUES IN PRECISION GRIP.

Journal of Medical Engineering & Technology, in Press.

Source material: ESA's 35th and 38th Parabolic Flight campaigns.

Objective: As spin-off from ESA's parabolic flight campaigns, to describe the specific device used for investigation of forces and torsion is precision grip.

Subjects: More than 30 subjects have indirectly participated in the development of this device through use onboard ESA's parabolic flights as test subjects.

Test regime: These are described the in reference paper identified in the paper of O. White in Newsletter nr. 2, May 2007.

Results: A device has been developed for the measurement of 3D forces and torques for the study of precision grip.

CAIANI, E. G., L. WEINERT, M. TAKEUCHI, F. VERONESI, L. SUGENG, C. CORSI, A. CAPDEROU, S. CERUTTI, P. VAIDA, AND R.M. LANG:

EVALUATION OF ALTERATIONS ON MITRALANNULUS VELOCITIES, STRAIN, AND STRAIN RATE DUE TO ABRUPT CHANGES IN PRELOAD ELICITED BY PARABOLIC FLIGHT.

J. Appl Physiol 103: 80-87, 2007

Source material: ESA's 41st Parabolic Flight campaign. November 2005.

Objective: To investigate the effect of g-load on the so-called preload of the heart, in three situations, namely 1 g, 1.8 g onboard the plane and 0 g onboard the plane. The central parameter measured was the blood velocity into and internally in the heart cavities, by use of a Echo Doppler flow measurements.

Subjects: Ten persons onboard ESA's 41st parabolic flight campaign in November 2005.

Test regime: Doppler flow measurements were done in ten subjects in the three situations, in addition to a situation where the return of blood to the heart could be manipulated by means of a Lower Body Negative Pressure device. This manipulation was applied in a random fashion during 0-g levels.

Results: Based on the availability of three distinctly different g-levels of which one is a 0-g level, the parabolic flight has made it possible to make these flow measurements with high accuracy, not the least based on the repetition of the same measurement cycle up to ten times or more in the same subject.
Some clinical conclusions can be drawn from this study regarding different pre-loading situations seen in patients.

LAKEHAL, DJAMEL, G. LARRIGNON, C. NARAYANAN:

COMPUTATIONAL HEAT TRANSFER AND TWO-PHASE FLOW TOPOLOGY IN MINIATURE TUBES.

Microfluid Nanofluid, Springer. Acceptecd for publication 16 April 2007

Source material: Microgravity Application Programme (MAP), project no. AO-1999-045 preparatory study.

Objective: Study of heat transfer mechanisms in small tubes, as a means to develop strategies for micro-cooling (cooling of emerging technologies) with applications in "ink-jets, electro-thermal systems, MEMS design, computer chips cooling and medical diagnostics devices e.g. bio-chips"

Subjects: Not applicable

Test regime: "The 2-D axisymmetric simulations were performed in a 1 mm diameter tube heated at the surface, in which air and water were injected as co-flowing streams. The computational strategy combines the unsteady Navier-Stokes equations for the flow and Level Sets (LS) for interface dynamics."

Results: Heat transfer in small tubes has been studied. Demonstration of the fact, that two-phase flow is higher than single-phase. Difference in heat transfer between 'slug flow' and 'bubbly flow' have been revealed and described. It is found that bubbly and slug patterns transport 3-4 times more heat from the tube wall, to the bulk flow than pure water flow.

DAS, K.S., AND C.A. WARD:

SURFACE THERMAL CAPACITY AND ITS EFFECTS ON THE BOUNDARY CONDITIONS AT FLUID-FLUID INTERFACES.

Physical Review E 75, 065303(R) (2007). Scientific paper.

Source material: Preparatory experiment for the Microgravity Application Programme projects, AO-99-110, AO-2004-096, and AO-2004-072, all related to the CIMEX project: Convection and Interfacial Mass Exchange. (CIMEX-2 equipment, TEPLO now flies onboard FOTON-M3, September 2007)

Objective: Surface Tension Driven (STD) convection in the context of fluid-fluid interfaces is studied. The focal problem is that in present calculations of the energy status and transfer in the liquid-vapour interface, the energy conservation principle cannot be fulfilled, unless an additional factor is considered/found. This study introduces a newly measured property, the surface thermal capacity, as being the missing component in the energy conservation equation.

Subjects: Not applicable

Test regime: A setup in the form of a 4˚C temperature stabilised chamber connected to a vacuum pump, and to a mass spectrometer has an arrangement whereby water can be introduced into a funnel, forming a well defined surface from which water vapour arises. The setup allows to estimate the rate with which evaporation is taking place. This rate has been estimated at the point where the water surface is not changing.

ROISMAN, ILIA, T. GAMBARYAN-ROISMAN, O. KYRIOPOULOS, , P. STEPHAN, C. TROPEA:

BREAKUP AND ATOMIZATION OF A STRETCHING CROWN.

Physical Review E 76, 026302 (2007). Scientific paper.

Source material: ESA's 44th Parabolic Flight Campaign, October 2006, has been the basis for production of this paper. The team is formed by members of the Microgravity Application Programme project number AO-2004-132 'DOLFIN'.

Objective: "The present paper is aimed at an investigation of the mechanisms of splash produced by spray impact. This study includes experimental observations of the shape of the liquid film and recognition of various modes of atomization...."
" The prediction of the parameters of the secondary spray associated with spray impact is required for the design of the atomizers based on the spray-wall interaction principle – for example the air blast atomizers for gas turbines. ..."

Subjects: Not applicable

Test regime: Video recording of splash impact was made possible in the experimental setup consisting of a test cell providing a spray directional generator (atomizer) sending spray on to the detection surface under a 30˚angle limitation. This scenario was repeated with different volumetric rates corresponding to different injection pressures, and the experiment was performed on the ground as well as onboard ESA's parabolic flight platform.

Results: A number of detailed, high resolution data was obtained, allowing for improved interpretation of splash scenarios.

BRINCKMANN, ENNO:

BIOLOGY IN SPACE AND LIFE ON EARTH

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"This concise yet comprehensive treatment of the effects of spaceflight on biological systems includes issues at the forefront of life sciences research, such as gravitational biology, immune system response, bone cell formation and the effects of radiation on biosystems. ....."
Go to relevant web site here.

VERHEYDEN, B., F. BECKERS, K. COUCKUYT, J. LIU AND A.E. AUBERT:

RESPIRATORY MODULATION OF CARDIOVASCULAR RHYTHMS BEFORE AND AFTER SHORT-DURATION HUMAN SPACEFLIGHT

Acta Physiol 2007, in press. Scientific paper.

Source material: Space Crews from the bilateral Soyuz exchange missions Odissea (Belgium), Cervantes (Spain), and DELTA (Netherlands) have participated in the underlying experiments leading up to this scientific publication.

Objective: The effector system of maintaining a blood pressure within the normal range is the so-called baroreceptor system, located in heart, lung and in the carotid arteries on the side aspect of the neck. This reflex undergoes alterations in the course of a spaceflight. In Earth bound situations it also is seen to be influenced by activity related factors. Changes in the gain of this reflex are involved in the response to vertical and horizontal body positions on Earth.
This scientist has focused the investigation on to which extent respiration - known to have an influence on heart rate variations - maintains the same or has changed impact on heart rate variation after short term spaceflight.

Subjects: 5 astronauts and cosmonauts onboard the above missions participated in the measurements for this study, which took place before and after the flight phase of some 10 days duration.

Test regime: Data was recorded at return plus 1 day and later after 25 days. Diverse breathing patterns were induced whilst heart and breathing parameters were recorded.

Results: It is concluded, that "short-duration spaceflight reduces respiratory modulation of HR and decreased cardiac baroreflex gain without affecting post-flight arterial blood pressure dynamics. ...."

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